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(54) **Chemical composition, redispersible in aqueous media, containing a copolymer and a protective colloid, its aqueous polymer dispersion, methods for their production and the use thereof**

Chemische Zusammensetzung, redispersierbar im wässrigen Milieu enthaltend ein Copolymer und ein Schutzkolloid, ihre wässrige Polymerdispersion, Verfahren zu ihrer Herstellung und ihre Verwendung

Composition chimique redispersable dans un milieu aqueux contenant un copolymère et un colloïde protecteur, sa dispersion aqueuse de polymère, procédé de sa production et son utilisation

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Description

[0001] The invention relates to a chemical composition, which is redispersible in aqueous media, containing a) a copolymer based on styrene and/or at least one alkyl (meth)acrylate the alkyl group of which has a chain length of 1 to 14 carbon atoms, the amount of styrene and/or alkyl (meth)acrylate being $\geq 50\%$ by weight, based on the total monomers, as well as at least one further comonomer, and b) a water-soluble polymer protective colloid, wherein 2 to 30 parts by weight of the water-soluble polymer protective colloid are allotted to 100 parts by weight of the copolymer, as well as c) optional further additives. The invention further relates to, the production of an aqueous polymer dispersion of said chemical composition and also special uses of the chemical composition.

[0002] Prior art of the above described nature results e.g. from EP 0 538 571 A (Applicant: Hüls AG). This application discloses a method for producing protective-colloid-stabilized emulsifier-free, aqueous plastic dispersions on the basis of $> 50\%$ by weight of styrene and/or C_1 - C_8 -alkyl(meth)acrylate, on the basis of the total monomers, by semi-continuous polymerization of the monomers, in aqueous phase as dispersion medium in presence of a water-soluble polyvinyl alcohol as protective colloid, and a radical initiator, or of an initiator system consisting of a radical initiator and an aqueous reduction agent. The polymerization is carried out in a monomer addition operation, the total polyvinyl alcohol quantity being taken into the receiver. The requirement of this prior art, i.e. to work without emulsifier, is to avoid problems otherwise appearing with the use of protective-colloid-stabilized plastic dispersions. So, emulsifiers are considered to be undesirable because they have e.g. a negative influence on the film formation. As advantageous is mentioned, that according to such teaching, the aqueous polymer dispersion has a comparatively low residual monomer contents of less than 10 ppm. The method according to EP 0 538 571 A1 is little flexible because, apart from the requirement of the absence of an emulsifier, it is subject to a large number of strong limitations. So e.g. must be proceeded strongly semi-continuously. It is also disadvantageous that a special protective colloid in the form of water-soluble polyvinyl alcohol is mandatorily to be employed. The same holds true for polyethylene oxide which likewise mandatorily must be used in the method according to EP 0 538 572 A1. Although this leads to an advantageous process sequence and also to the desired redispersibility of the substance obtained from the aqueous plastic dispersion, it may, however, have a disadvantageous influence during later cases of application of the plastic dispersion or the composition obtainable therefrom. In single cases it is also desirable to replace the polyvinyl alcohol by other suitable polymeric protective colloids on account of its relatively high price.

[0003] Also prior art according to EP 0 062 106 B1 (patent owner: Wacker-Chemie GmbH) is relevant. There a method for producing aqueous dispersions on the basis of polymers is described which consist of at least 60 % by weight of (meth)acrylic ester units and/or styrene units, and the solid contents of which amounts to approximately 30 to 70 % by weight. The method is carried out in a way that 4 to 20 % by weight polyvinyl alcohol, based upon the monomers, are present in the aqueous dispersion during production. Further, the total weight of the monomer concentration is kept below 20 % by weight during the total duration of the reaction, and the bulk of the monomers is dosed-in during the reaction in the form of a preemulsion. Also that method shows a lack of flexibility, as mentioned above with reference to EP 0 538 571 A1. Moreover it must be judged to be disadvantageous that a preemulsion must be formed in a technically complicated manner. Also the residual monomer contents of the obtained aqueous dispersion amounts to approximately 500 ppm which is bad with respect to the above described prior art according to EP 0 538 571. A high residual monomer content has a disadvantageous effect seen under a variety of points of view. So, e.g., the monomer will evaporate during a later application which is hazardous, in particular under considerations of toxicity. It would be, therefore, advantageous to keep the residual monomer contents as low as possible.

[0004] According to JP-02018466 an emulsion polymer (A) is prepared from a mixture of unsaturated monomers which are composed of 0.3 - 20 % by weight of a monomer having an epoxy group, 0.3 - 20 % by weight of an unsaturated monomer having at least one aldehyde or ketone group in its molecule, and 99.4 - 60 % by weight of another unsaturated monomer. For use the emulsion polymer is mixed with an aqueous polyhydrazine compound (B) and/or an amino compound (C) with active hydrogen. Nowhere is reference made to the idea of preparing a redispersible material from dispersion (A) e.g. by spray drying or other measures. In fact the clear idea is that (A) is only to be used in combination with (B) and/or (C). When removing water from such a mixed system it would react in chemically irreversible manner and would have nothing in common with a redispersible material. JP-02108466 also provides for the use of protective colloids. Details on the nature of the protective colloid show that it is built up from at least three different monomer units, including a carbonyl group-containing monomer with at least one aldehyde or ketone group and a double bond, a monoolefinically unsaturated carboxylic acid, and an alkyl ester of acrylic or methacrylic acid. The chemically specified, water-soluble protective colloid is not only highly complex, but necessarily contains in a monomer unit an aldehyde and/or ketone group. Such aldehyde and ketone groups can be highly prejudicial in the desired polymerization process in that they act as chain transfer agents.

[0005] The prior art according to JP-63156871 is directed to an emulsion polymer according to the core/shell principle. It aims at a particular difference between core and shell material with respect to the glass transition point. In the core the glass transition point is to be 20°C or lower, whereas in the shell it is 40°C or higher. This copolymer is present in

an aqueous emulsion. It is not stated that this material or aqueous dispersion is to be freed from its aqueous fraction. Thus, a redispersible material or powder is not disclosed. In fact, there are considerations, according to which redispersibility is excluded. It is pointed out that the multistage polymerization performed in the aqueous medium takes place in the presence of an emulsifier. Dispersing agents, inter alia polyacrylate, carboxymethyl cellulose and "Poval"

(= polyvinyl alcohol), are only added after concluding the polymerization, in order to stabilise the dispersion obtained. [0006] JP-58-162611 discloses a method of manufacturing acrylic polymer emulsions, wherein acrylic monomers are emulsion-polymerized in the presence of completely hydrogenated polyvinyl alcohol which contains compounds which have sulfonic acid or sulphuric acid groups, bonded to the polyvinyl groups in the polyvinyl alcohol. Glycidyl methacrylate may be used among other monomers. It is generally accepted that the presence of sulfonic acid or sulphuric acid groups renders the emulsion polymer produced more hydrophilic. The increased hydrophilicity of the polymer may lead to a disadvantageous increase of the water sensitiveness in the final applications.

[0007] It is the object of the invention to develop the chemical compositions produced in accordance with the above described methods, so that the same, on the one hand, at least preserve their advantageous properties of said known products or in special cases even exhibit improved properties, the production of which, however, with a view to process regime and the selection of starting materials, in particular the water-soluble protective colloid, may be made more flexible. Additionally, those chemical compositions should be improved so that they would produce in their final applications, such as in plastic-containing, cement-bonded systems, improved application products on the basis of desired sequential reactions. Such general object includes also an improved method for producing such chemical composition and more advantageous application possibilities such as e.g. the improvement of the adhesive pull strength of certain materials, such as tile adhesives.

[0008] Emulsion polymers are usually provided as aqueous dispersions with an amount of aqueous fraction of more or less than 50%. When transporting the dispersions over long distances, or if the manufacture of dry pre-mixes is desired, the high proportion of water in such dispersions is disadvantageous. It is therefore a need for dry chemical compositions, in particular in powdery form, which after reconstitution in water resemble the properties of the initial dispersions. Accordingly, the chemical composition, in particular in powdery form, must be redispersible in an aqueous medium. Also, the reactivity of functional monomer units has to be maintained. The present invention aims to provide a chemical composition with the required features.

[0009] The above object is achieved according to the invention by a chemical composition which is redispersible in aqueous media, containing a) a copolymer based on styrene and/or at least one alkyl (meth)acrylate the alkyl group of which has a chain length of 1 to 14 carbon atoms, the amount of styrene and/or alkyl (meth)acrylate being $\geq 50\%$ by weight, based on the total monomers, as well as at least one further comonomer, and b) a water-soluble polymeric protective colloid, wherein 2 to 30 parts by weight of the water-soluble polymeric protective colloid are allotted to 100 parts by weight of the copolymer, as well as c) optional further additives, which is characterized in that the copolymer comprises 0.1 to 50% by weight units of an epoxide group-containing ethylenically unsaturated comonomer and said units contain reactive epoxide groups, wherein polymeric acrylic protective colloids are excluded which have monomer units with at least one aldehyde or ketone group.

[0010] The composition according to the invention contains therefore a copolymer based on styrene and/or at least one alkyl (meth)acrylate and at least one further comonomer. Said at least one further comonomer is an epoxide-group-containing ethylenically unsaturated comonomer which may be an ester or an ether. Such ester is preferably a glycidyl (meth)acrylate, and the ether is preferably a glycidyl vinyl ether and/or a glycidyl allyl ether.

[0011] For obtaining the above objective it is most important that the reactive epoxide groups of said polymerized-in comonomer are largely preserved during the polymerization process. So the epoxide functionality of the epoxide group-containing ethylenically unsaturated comonomer polymerized into the copolymer amounts preferably to at least 30%, in particular to approximately 60%, or even 90% and more.

[0012] The quantity of such comonomer within the described copolymer based on styrene and/or at least one alkyl (meth)acrylate amounts to, as said above, 0.1 to 50 % by weight. Preferably the copolymer contains 1 to 25 % by weight units of the epoxide group-containing ethylenically unsaturated comonomer, in particular a range of 2 to 20 % by weight.

[0013] The styrene and/or alkyl (meth)acrylate quantity within the copolymer amounts to at least 50 % by weight, preferably the amount of styrene and/or alkyl (meth)acrylate is 70 to 80 % by weight, based on the total monomers. The skilled artisan is conscious of the fact that he may use also substituted styrene compounds, in particular such as modified with alkyl sulfonyl and carboxyl groups instead of styrene compounds. The term "alkyl (meth)acrylate" is to comprise also mixtures of acrylates and methacrylates or also mixtures of various alkylacrylates and methacrylates. In this context also the feature of "alkyl group" is to be understood to contain straight, branched chain and cyclic alkyl groups. Among the cyclic groups are to be mentioned e.g. cyclohexyl, phenyl, alkylphenyl, isobornyl, furfuryl, tetrahydrofurfuryl or dicylopentyl groups. Preferred are, however, straight and branched chain alkyl groups, in particular having a chain length of 1 to 18 carbon atoms, preferably 1 to 8 carbon atoms. Among such alkyl (meth)acrylates are to be mentioned in particular methyl (meth)acrylate, ethyl (meth)acrylate, butyl (meth)acrylate and/or 2-ethyl-hexyl (meth)

acrylate.

[0014] In particular cases it may be advantageous, for modifying the properties of the chemical composition in accordance with the invention, facultatively to polymerize in yet further comonomers, in addition to the above mentioned mandatorily required comonomers. As preferred examples there may be mentioned in this context: (meth)acrylic acid, (meth)acryl amide and derivatives thereof, such as N,N-dialkyl (meth)acrylamide, N-methylol (meth)acrylamide and (meth)acrylonitrile, at the alkyl chain functionalized acryl(meth)acrylates, in particular hydroxy alkyl (meth)acrylates, such as hydroxy ethyl (meth)acrylate, oligo and polyethylene glycol (meth)acrylate, aminoalkyl(meth)acrylate and N, N derivatives thereof, trialkylammonium alkyl(meth)acrylates, itaconic acid, maleic acid and fumaric acid and esters thereof, amides, functionalized amides and nitriles. So is it e.g. possible to control the hydrophilicity of the chemical compositions using some of such comonomers. A high hydrophilicity results in an improvement of the redispersibility under standard conditions.

[0015] Also crosslinking monomers containing two or more polymerizable double bonds may be employed. As examples may be mentioned: divinyl benzene, diallylphthalate, triallylcyanurate, ethylene glycol di(meth)acrylate, butanediol di(meth)acrylate, hexanediol di(meth)acrylate, diethylene glycol di(meth)acrylate, allyl (meth)acrylate, with divinyl benzene, ethylene glycol di(meth)acrylate and allyl (meth)acrylate being preferred.

[0016] Preferably, comonomers having aldehyde or ketone groups in their molecule are present in a quantity of less than 5% by weight, based on the total monomers, particularly less than 1 % by weight, and especially less than 0.3% by weight.

[0017] An essential constituent of the chemical composition is also the polymeric protective colloid. That is, on the one hand, essential for the production of the aqueous polymer dispersion, on the other hand also at least co-responsible for the desired redispersibility of the chemical composition in aqueous systems.

[0018] The term "redispersible" or "redispersibility" used herein is taken to mean that the composition, if present in dry form, in particular as dry powder, is redispersible in aqueous media, in particular in water itself. This requirement of redispersibility is complied with by a re-obtained dispersion which is stable for preferably at least about 2 hours, in particular at least about 12 hours, and under ideal conditions more than 24 hours. In other words, there will not occur a significant precipitation. For the determination of such redispersibility the following method could preferably be employed: 50g of an essentially lump-free powder are mixed with 50g water in a beaker of a diameter of 8 cm and a maximum filling volume of 300 cm³. Stirring is performed with a propeller mixer (3 propellers and a standard diameter of 60 mm) with 1.000 rpm. The dispersion obtained is visually evaluated after 2, 12 and 24 hours, respectively.

[0019] Usually the primary particle size in a copolymer dispersion obtained by emulsion polymerization is such that 98% of the particles have a diameter of below 3,5µm. In an ideally redispersible powder, after 15 minutes of stirring, 50% of the particles have recovered the original low particle size, with the reminder being present as partially broken agglomerates, which disintegrate upon further stirring.

[0020] The polymer protective colloid must therefore be water-soluble in the first place. The water-solubility is effected by the more or less polar groups which are present within the polymeric protective colloid. It is possible to explain their function during the production of the chemical composition and as regards the above mentioned redispersibility e.g. in a manner as results from the doctor's thesis by K. Bruger: "Zum Einfluß des Polymerisationsgrades teilweiseester Polyvinylacetate auf die Stabilität der Suspensionspolymerisierung von Styrol" (Contribution to the Influence of the Degree of Polymerization of Partly Saponified Polyvinylacetates on the Stability of Suspension Polymerization of Styrene), TU Munich, Germany, 1993, pages 12/13. Although this thesis treats the suspension polymerization, the effects may be transferred to the emulsion polymerization as well without problems, since the polymerization polymerisates differ primarily in the particle size and the protective colloid portion only. It could, thereby, be assumed that the protective colloid is adsorbed at the monomer surface, effecting thus a steric stabilization.

[0021] The present invention is substantially unrestricted as regards the selection of the water-soluble polymeric protective colloid with the above exception of polyacrylates or polymethacrylates having monomer units with at least one aldehyde or ketone group. So e.g., the following protective colloids may be used: polyethylene oxide (cf. EP 538 572), starch and starch derivatives (cf. EP 131 899 and literature there mentioned), gelatin, casein and other water-soluble proteins (cf. EP 134 450 and literature there mentioned), water-soluble cellulose derivatives such as hydroxyethyl cellulose (cf. EP 99 463), polysaccharides (cf. JP 1-131447), water-soluble polyacrylates, such as acrylic acid copolymerizates, ethylene oxide-propylene oxide copolymers, functionalized polyvinyl alcohol, such as acetoacetalized polyvinyl alcohol (cf. JP 6-19057), polyvinyl alcohol and/or polyvinyl pyrrolidone. Polyvinyl alcohol and/or polyacrylates and/or polyvinyl pyrrolidone are preferred as water-soluble protective colloid. The polyvinyl alcohol has preferably an average molecular weight of approximately 10,000 to 250,000, in particular approximately 20,000 to 200,000, and a hydrolysis degree of 80 to 95 %, in particular approximately 83 to 92%. The polyvinyl pyrrolidone is preferably characterized by an average molecular weight of 1,000 to 1,000,000, in particular 7,000 to 700,000.

[0022] As already stated, the components a) and b) in the present invention must obey the quantitative general condition, according to which 2 to 30 parts by weight of water-soluble polymeric protective colloid b), in particular 5 to 15 parts by weight, are to be allotted to each 100 parts by weight of copolymer a).

[0023] For controlling the properties of the chemical composition according to the invention, it may contain, in addition to the components a) and b), optionally still other additives. Such are e.g. additional protective colloids, in particular also in the form of a water-soluble polymeric protective colloid which may be equal to or also different from the already discussed component b). Furthermore the following additives may be added: plasticizers, film-forming aids, preservation agents, emulsifiers, wetting agents, defoamers, thickening agents, rheology modification agents, crosslinking agents, resins, adhesive adjuvants, fillers, anti-blocking agents and pigments.

[0024] Since the chemical composition according to the invention is preferably formed by emulsion polymerization, in its production advantageously also various emulsifiers may be used which are also effective for redispersion. Such emulsifiers may be non-ionic emulsifiers such as e.g. alkyl phenol EO 10 or EO 50 (EO = degree of ethoxylation), in particular nonyl phenol EO 10 or EO 50, alkyl alcohol EO 15 or 25, in particular C13-alcohol EO 15 or 25, sorbitan fatty acid ester, ethoxylated fatty acid esters, glycerin fatty acid esters, ethoxylated alkylamines, anionic emulsifiers such as in particular ammonium, sodium or calcium salts of various fatty acids, alkylaryl sulfonic acids, alkyl sulfonates, alkyl ether sulfates, alkyl sulfate esters, alkyl sulfonates, ethoxylated alkyl ether sulfonates, ethoxylated alkylallyl ether sulfonic acid esters, alkylphenol ether sulfates, dialkylsulfosuccinates, cationic emulsifiers such as in particular alkylammonium acetate or quaternary ammonium and pyridinium compounds, amphoteric emulsifiers such as alkylbetaines, copolymerizable emulsifiers such as sodium dodecyl allyl sulfosuccinate. Also mixtures of emulsifiers may be used.

[0025] The chemical composition according to the invention may be obtained from an aqueous polymer dispersion which is made by means of the method as described in further details hereinafter. Utilizable methods for separating the aqueous medium are filtration, centrifuging and/or drying methods, in particular spray drying. In case of the preferred spray drying, there is produced a powdery product which may later advantageously be used. If solid compact compositions are formed when separating the aqueous medium, it may advantageously be envisaged to grind them first by usual grinding procedures.

[0026] Object of the present invention is also a method for producing dispersions having a chemical composition which method comprises i) polymerizing monomers of $\geq 50\%$ by weight, based on the total monomers, of styrene and/or alkyl (meth)acrylate, 0.1 to 50% by weight, based on the total monomers, of an epoxide group-containing ethylenically unsaturated comonomer, and, optionally, further additives, in an aqueous phase as dispersion medium in the presence of the water-soluble polymeric protective colloid and a radical initiator wherein the pH value is kept at 4 to 9, to produce an aqueous polymer dispersion, ii) spray drying the aqueous dispersion to produce a solid composition in powdery form, wherein the dispersion particles are maintained at a temperature of not more than 100°C.

[0027] The polymerization of the monomers is carried out in aqueous phase as dispersion medium in presence of a free radical initiator. The qualitative and quantitative general conditions as explained in the context of the chemical composition according to the invention apply, mutatis mutandis, for the method according to the invention, and vice versa, what is to be pointed out here in order to avoid repetitions. So, e.g., the quantity of the used epoxy-group-containing ethylenically unsaturated comonomer must amount to approximately 0.1 to 50 % by weight, based upon the total monomers.

[0028] The addition of the epoxide-group-containing ethylenically unsaturated comonomer is advantageously carried out in such a way that a core/shell structure appears in the polymer, in which the proportion of this comonomer is bigger in the shell than in the core. Thereby the expensive comonomer may selectively be arranged at the surface of the latex particle. Thereby a substantially higher portion of the epoxide groups participates in a subsequent crosslinking reaction.

[0029] It has been found that on expert observation of the general conditions in accordance with the invention, the residual monomer contents is negligible. It even may be less than 150 ppm, it being possible also to totally exclude the residual monomers.

[0030] The polymerization is preferably carried out between approximately 50 and 100°C, in particular between approximately 60 and 90°C. In single cases, the initial temperature amounts to preferably approximately 70°C. The heat evolution resulting from the exothermic reaction may be used to reach a reaction temperature between 80 and 90°C, a cooling being possibly required for not to exceed the stated temperature range. It is also possible to remove the total heat evolved in order to maintain the initial temperature of approximately 70°C during the reaction or even to reduce it.

[0031] In particular cases also an autoclave may be used, which offers the possibility of carrying out the polymerization above 100°C. Thereby the conditions must thus be set that the epoxide functionality of the comonomer, subject matter of the invention, in the final polymer is substantially maintained.

[0032] An especially important feature during the process according to the invention is, that the epoxide functionality of the already discussed epoxide-group-containing, ethylenically unsaturated, comonomer is largely conserved. That means that the epoxide groups do not enter a reaction during the process. So, e.g., a too high or too low pH-value may have the effect that the epoxide groups are no longer available after the polymerization due to a chemical reaction. It is therefore advantageous if the pH value in the aqueous emulsion medium is kept at approximately 4 to 10, in particular approximately 5 to 9, preferably 7, during the polymerization. This is effected e.g. by suitable buffer systems such as with sodium bicarbonate. Principally it is possible to use any buffer systems which is suitable for the respective pH

value as desired.

[0033] In cases in which the protective-colloid-stabilized dispersion is directly used, the addition of water-miscible organic liquids, such as methanol, ethanol and propanol, into the polymerization process has certain advantages, obtaining thus e.g. more waterproof systems.

[0034] With respect to the addition of the protective colloid, the method in accordance with the invention is not subject to the restrictions as described above in connection with prior art. So the addition of the protective colloid may be carried out in accordance with the prior art according to EP 0 538 571 A1 in adding the total amount of protective colloid into the receiver. It is also possible to add part, e.g. 85%, into the receiver and the rest of 15% within a period of time of approximately 30 minutes. In case of another embodiment e.g. 50% may be added into the receiver and the rest of 50% during the whole period of time of the addition of the monomer. Such portion of the protective colloid as added during the reaction may be dosed-in in the form of an aqueous solution or in the form of a mixture of aqueous solution with part of, or the total quantity of the monomer. According to the present invention it is preferred that an additional polymeric protective colloid is added to the aqueous dispersion prior to spray drying.

[0035] Principally the method according to the invention may be carried out continuously, semi-continuously or as a batch process. Further, the skilled artisan knows that he has to take into consideration the basic principles of an emulsion polymerization for carrying out the method according to the invention. So, as already pointed out, free radical initiators may be used for carrying out the polymerization. The radical initiators are either water-soluble or essentially non-water-soluble, but in such case monomer-soluble. Suitable water-soluble initiators are sodium, potassium and ammonium peroxodisulfate, hydrogen peroxide and water-soluble azo compounds such as 2,2'-azobis(2-amidinopropane)dihydrochloride. Peroxodisulfates are preferred. Suitable monomer-soluble initiators include organic hydroperoxides such as tert-butyl hydroperoxide, dibutyl peroxide, pinane hydroperoxide, p-menthane hydroperoxide, cumene hydroperoxide and diisopropyl phenyl hydroperoxide, organic peroxides such as dibenzoyl peroxide, dialauryl peroxide and diacetyl peroxide and monomer-soluble azo compounds, such as azoisobutyronitrile. Tert-butyl hydroperoxide is preferred. Also mixtures of initiators may be used.

[0036] Instead of a radical initiator also an initiator system consisting of a radical initiator as described above and a water-soluble reduction agent may be used. The water-soluble reduction agents have the effect of activators for the initiators. Suitable reduction agents are ascorbic acid, sodium-, potassium- and ammonium-sulfite, -bisulfite and -metabisulfite, sodium formaldehyde sulfoxylate, tartaric acid, citric acid and glucose. They may be used in combination with a heavy-metal salt. The reduction agents are usually used in a quantity of approximately 0.01 to 2 % by weight, based on the total monomers. They are usually dosed during the polymerization.

[0037] The actual free radical initiator is formed during the polymerization which may occur e.g., by thermic disintegration of the above initiator, but also by reaction of the initiator with an aqueous reduction agent. The initiators or initiator combinations are usually used in a quantity of approximately 0.01 to 2 % by weight based on the total monomers.

[0038] It may also be of advantage if water-soluble viscosity control agents are used during the method in accordance with the invention. The water-soluble viscosity control agents act as radical transfer agents during the grafting of the monomers on the polyvinyl alcohol. Suitable viscosity control agents are low-molecular organic sulfur compounds, such as e.g. thioglycolic acid, and low-molecular non-surface-active amino alcohol compounds, such as e.g. triethanolamine, as well as aldehydes, such as acetaldehyde, halogenated hydrocarbons having 1 to 8 carbon atoms such as methylene chloride. Triethanolamine is preferred. The viscosity control agent as a rule is used in a quantity of approximately 0.01 to 2 % by weight, based on the total monomers. A preferred embodiment of the method according to the invention consists in carrying out the polymerization in presence of a peroxodisulfate and a viscosity control agent. The peroxodisulfate may be placed into the receiver or dosed-in during the polymerization obtaining thus redispersible dispersions having a high hydrophilicity.

[0039] Polymerization may be carried out in a monomer addition process with the possibility of varying the manner of addition of the protective colloid. The monomers are dosed-in during the polymerization. Part of the monomers may be placed into the receiver. But part of the monomer mixture may also be placed into the receiver and be polymerized in a batch operation thereby producing a seed latex. Polymerization is subsequently carried out in monomer addition process. The viscosity of the dispersion may be controlled i.e. by the period of dosing-in of the monomers. The solid content of the dispersion may amount to between approximately 30 and 70%.

[0040] The chemical compositions in accordance with the present invention may find a variety of uses.

[0041] The chemical compositions in accordance with the present invention are suitable for being used in plastic-comprising, cement-bonded systems, in particular in mortars, cement paints and adhesives, and plastic-bonded, cement-free binders, in particular in gypsum mortars, plasters, carpet, wood, powder and floor adhesives and in wallpaper glues, in dispersion powder paints and in glass fiber composite systems. In a solid form, the chemical composition in accordance with the present invention may be included in powdery readymade mixtures to be stirred by the user into water or other liquids prior to being used. It is also feasible that the aqueous dispersion of the chemical composition (obtained by emulsion polymerization or also reconstituted from the solid chemical composition) and a mixture containing the other constituents are delivered in the form of separate components and are combined immediately prior

to use.

[0042] The desired improved properties of the systems comprising the chemical compositions in accordance with the invention are based upon a reaction of the epoxide groups with suitable reactants or the epoxide groups with themselves. So in hydraulic binders, e.g. a reaction of the epoxide groups may take place with free hydroxylic groups of the silicate constituents contained therein, in dispersion paints with amino or hydroxy groups of pigments contained therein. It should be noted that the high pH value prevailing generally in hydraulic binders increases the nucleophilicity of the mentioned hydroxy and/or amino groups. In the absence of suitable reactants in the application medium, a crosslinking may be obtained by incorporation of crosslinking agents or hardeners. Suitable hardening systems are e. g. di-, tri-, oligo- and polyamines, deprotonated di-, tri- oligo- and polycarboxylic acids and hydroxy-functionalized compounds such as alcohols or silanols. Advantageously also dispersions or powders of amino and/or carboxylic-functionalized polymers may be used. Alkalies, such as sodium hydroxide and potassium hydroxide, alkaline earths such as calcium hydroxide, or acids such as, H_3PO_4 , H_2SO_4 , and HCl may also be used in order to optimize the pH value, because both a high pH value and a low pH value causes the self-crosslinking of the epoxide groups. Furthermore, transition metal compounds such as $AlCl_3$, $SbCl_5$, $FeBr_3$, $FeCl_3$, $SnCl_4$, $TiCl_4$, $ZnCl_2$, $Al(i-OC_3H_7)_3$ and also BF_3 or BCl_3 may be used. The hardeners could be included into dry mixtures, being delivered as separate components or be added to the above said mixture.

[0043] The advantages connected with the invention are manifold. So has the method according to the invention a surprising flexibility as regards the quantitative and qualitative general conditions as opposed to the initially mentioned comparative teachings. It is not required to renounce the use of emulsifiers, and yet the obtained method products show advantageous properties, also as regards the above mentioned film formation. A special advantage resides in the fact that a product is obtained which leads to chemical systems which exhibit especially valuable properties in the pronounced final applications due to the occurring crosslinking reactions. In case of use of the inventive chemical composition in tile adhesive formulations e.g. both the adhesion of the tile and the cohesion of the mortar are greatly improved. In this respect said crosslinking shows an outspoken improvement wherever high water proofness is to be obtained. The residual monomer contents in the products according to the invention is 150 ppm and less, down to the virtually complete exclusion. It is therefore negligible. Moreover, the products according to the invention may be used in an extraordinarily high variety of fields of application which are not related to one another.

[0044] The invention is subsequently to be explained in further details by the following examples.

Example 1

[0045] 65 g of polyvinyl alcohol (PVA) having a hydrolysis degree of 88 % and a viscosity of 4 mPas (in the form of 4% aqueous solution) dissolved in 570 g water, were placed into a 2 liters glass reactor equipped with a stirrer and a temperature control device. The pH value was adjusted to approximately 7.5 using sodium bicarbonate. That solution was thermostated on 75°C. 5.3 g of tert-butyl hydroperoxide were added. Subsequently 764 g of monomer mixture consisting of 363 g of styrene, 363 g butyl acrylate and 38 g glycidyl methacrylate were added continuously during 3.5 hours, and parallel thereto 4.5 g sodium formaldehyde sulfoxylate in the form of 10% aqueous solution were dosed into the reactor during 5 hours. Half an hour after the commencement of the monomer addition, 11.5 g PVA (same hydrolysis degree and same viscosity as above) dissolved in 46 g water was continuously dosed into the reactor. The reaction temperature rose to 80°C. At the end of the monomer dosage 1.5g tert-butylhydroperoxide was added to the reaction mixture. After an overall reaction duration of 5.5 hours, the dispersion obtained was cooled and analysed. The solids amounted to 55.8%, the pH value to 7.1, the viscosity was 8230 mPas (according to Epprecht, beaker D and step 13) and the average particle size was 0.6 µm.

Comparative Example 2

[0046] Example 1 was repeated, but the monomer mixture consisted of 382 g styrene and 382 g butylacrylate only. The solids were 56.0 %, the pH value was 7.0, the viscosity was 6320 mPas (according to Epprecht, beaker D and step 13) and the average particle size was 0.5 µm.

Example 3

[0047] Example 1 was repeated, but prior to the commencement of the reaction only 34 g PVA dissolved in 570 g water were filled into the reactor. The solids amounted to 55.3%, the pH value was 7.4, the viscosity 1575 mPas (according to Epprecht, beaker C and step 13) and the average particle size was 0.7µm.

Example 4

[0048] Example 1 was repeated, but prior to the commencement of the reaction, 50 g PVA dissolved in 570 g water were filled into the reactor. In addition, 5.0 g of a mixture of ethoxylated linear fatty alcohols were stirred into the receiver. No PVA solution was added. The solids amounted to 55.6%, the pH value was 7.2, the viscosity was 2810 mPas (according to Epprecht, beaker C and step 13) and the average particle size 0.9 μm .

Example 5

[0049] Example 1 was repeated, but prior to the commencement of the reaction, 61 g PVA dissolved in 570 g water were filled into the reactor. In addition, 7.6 g of a nonylphenol ethoxylate were stirred into the receiver. The monomer mixture was continuously dosed-in during 2.5 hours, the reaction temperature rising up to 85°C. The sodium formaldehyde sulfoxylate solution was dosed-in for 4 hours. No PVA solution was added. The total duration of the reaction was 4.5 hours. The solids amounted to 55.6%, the pH value was 8.0, the viscosity was 2810 mPas (according to Epprecht, beaker C and step 13) and the average particle size 0.7 μm .

Example 6

[0050] Example 1 was repeated, but prior to the commencement of the reaction, 38 g PVA dissolved in 525 g water were filled into the reactor. In addition, 3.8 g of a nonylphenol ethoxylate were stirred into the receiver. The monomer mixture was continuously dosed-in during 2.5 hours, the reaction temperature rising up to 85°C. The sodium formaldehyde sulfoxylate solution was dosed-in for 4 hours. With the commencement of the monomer addition, 38 g PVA dissolved in 153 g water were continuously dosed into the reactor parallel to the monomer addition and during 2.5 hours. The total duration of the reaction was 4.5 hours. The solids amounted to 54.0%, the pH value was 7.2, the viscosity was 3330 mPas (according to Epprecht, beaker C and step 13) and the average particle size 1.1 μm .

Example 7

[0051] Example 5 was repeated, but no nonylphenol ethoxylate was added. The monomer mixture consisting of 363 g styrene and 363 g butylacrylate was continuously dosed-in during 2.5 hours. 38 g glycidylmethacrylate was added to the reaction mixture half an hour after the end of the monomer addition within short time. The solids amounted to 55.9%, the pH value was 7.4, the viscosity was 7200 mPas (according to Epprecht, beaker D and step 13) and the average particle size 1.0 μm .

Example 8

[0052] Example 7 was repeated, however, instead of PVA the same quantity of polyvinylpyrrolidone (average molecular weight 8000 g/mol) was added. The solids amounted to 55.4%, the pH value was 7.9, the viscosity was 80 mPas (according to Epprecht, beaker B and step 13) and the average particle size 0.4 μm .

Example 9

[0053] The dispersions from the examples 1 and 2, called in the following dispersion 1 or dispersion 2 (comparative dispersion) were spray-dried according to the usual method by spraying the dispersions through two-substance-nozzles (dual-fluid-nozzle). Atomizing medium was air, prepressurized to 4 bar; the forming droplets were dried in direct-current line with air of 125°C.

[0054] Dispersions 1 and 2 and in water redispersed dispersion powder 1 (obtained from dispersion 1) were subsequently freeze-dried. Subsequently the soluble parts were solved out by means of chloroform. A ^{13}C -NMR (in CDCl_3) of the extracts of dispersion 1 and of the dispersion powder 1 showed both carbon atoms of the epoxide ring to be at 48.9 and 44.6 ppm respectively. Such bands were not observed in the extract of dispersion 2 (comparative dispersion). This clearly shows that the epoxide groups are still present both after the polymerization and after the spray-drying.

[0055] The obtained dispersion powders 1 and 2 were mixed each with 5 parts quartz sand 0.1-0.3 mm (59.9 parts), Portland cement PZ45 (31.8 parts), calcium hydroxide (2.9 parts) and methyl cellulose having a viscosity of 6000 mPas (as 2% aqueous solution; 0.4 parts) and mixed with water (22 parts). The thus obtained mortar was applied upon a concrete slab and subsequently stoneware tiles (5 x 5 cm) were laid into the mortar bed. After 28 days storage in normal climate (23°C and 50% rel. humidity of air) or 7 days storage in normal climate and 21 days storage in water respectively, the adhesive strengths in accordance with DIN 18'156, part 2, were measured. The thus obtained values (table 1) show clearly that mortar systems which contain the dispersion powder according to the invention increase

the adhesive strengths of tiles.

TABLE 1:

Adhesive pull strengths after dry and wet storage:		
Mode of storage	Dispersion powder 1 (according to the invention)	Dispersion powder 2 (compared)
Dry storage	1.25 N/mm ²	1.0 N/mm ²
Wet storage	0.85 N/mm ²	0.7 N/mm ²

Example 10 - Redispersibility test

[0056] The dispersion from Example 1 was spray-dried as described in Example 9 above. A free-flowing powder was obtained with no build-up at the walls of the spray-drying tower. 50g of this powder was placed in a beaker (8 cm diameter, maximum filling volume 300 cm³) and 50g water was added. Stirring was performed with a propeller mixer (3 propellers and a standard diameter of 60 mm) with 1000 rpm. After 15 minutes, stirring was discontinued, and a stable dispersion was obtained. Within 24 hours no coagulation or precipitation could be seen.

[0057] As comparison, a commercial emulsifier-protected styrene-acrylate-copolymeric dispersion was mixed with polyvinyl alcohol (cf. the prior art according to JP-63156871, discussed above). Spray-drying was carried out as in Example 9 above. During spray-drying, a large part of the dried substance deposited on the wall of the spray tower which remarkably reduced the yield. The rest of the powder obtained immediately formed lumps. The lumped material was sieved. 25g of the powder passing the sieve, was mixed with water. In order to obtain a slurry, triple the amount of water was required. Subsequently, the water/polymer mixture was stirred as described above. The particulate material was still present in the form of non-dispersible balls. The particle size did not change during stirring. No redispersion occurred. After two hours most of the particles had settled to form a precipitate.

Claims

1. Chemical composition which is redispersible in aqueous media, containing a) a copolymer based on styrene and/or at least one alkyl (meth)acrylate the alkyl group of which has a chain length of 1 to 14 carbon atoms, the amount of styrene and/or alkyl (meth)acrylate being $\geq 50\%$ by weight, based on the total monomers, as well as at least one further comonomer, and b) a water-soluble polymeric protective colloid, wherein 2 to 30 parts by weight of the water-soluble polymeric protective colloid are allotted to 100 parts by weight of the copolymer, as well as c) optional further additives, characterized in that the copolymer comprises 0.1 to 50% by weight units of an epoxide group-containing ethylenically unsaturated comonomer and said units contain reactive epoxide groups, wherein polymeric acrylic protective colloids are excluded which have monomer units with at least one aldehyde or ketone group.
2. Chemical composition according to claim 1, characterized in that the chemical composition contains a water-soluble protective colloid in the form of polyvinyl alcohol, polyvinyl pyrrolidone and/or polyacrylate.
3. Chemical composition according to claim 2, characterized in that the said polyvinyl alcohol has an average molecular weight of 10,000 to 200,000 and a degree of hydrolysis of 80 to 95 %, and the polyvinyl pyrrolidone has an average molecular weight of 1,000 to 1,000,000.
4. Chemical composition according to at least one of claims 1 to 3, characterized in that the alkyl (meth)acrylate is butyl (meth)acrylate, 2-ethyl hexyl (meth)acrylate and/or ethyl (meth)acrylate.
5. Chemical composition according to at least one of claims 1 to 4, characterized in that the epoxide group-containing ethylenically unsaturated comonomer is an ester or an ether.
6. Chemical composition according to claim 5, characterized in that the ester is glycidyl (meth)acrylate, and the ether is glycidyl vinyl ether and/or a glycidyl allyl ether.
7. Chemical composition according to at least one of the preceding claims, characterized in that the amount of styrene and/or alkyl (meth)acrylate is 70 to 80% by weight.
8. Chemical composition according to at least one of the preceding claims, characterized in that the copolymer con-

tains 1 to 25% by weight units of the epoxide group-containing ethylenically unsaturated comonomer.

9. Chemical composition according to at least one of the preceding claims, characterized in that the epoxide functionality of the epoxide group-containing ethylenically unsaturated comonomer polymerized into the copolymer amounts to at least 30%.

10. Method for producing dispersions having a chemical composition according to at least one of claims 1 to 9, which method comprises

i) polymerizing monomers of $\geq 50\%$ by weight, based on the total monomers, of styrene and/or alkyl (meth)acrylate, 0.1 to 50% by weight, based on the total monomers, of an epoxide group-containing ethylenically unsaturated comonomer, and, optionally, further additives, in an aqueous phase as dispersion medium in the presence of the water-soluble polymeric protective colloid and a radical initiator wherein the pH value is kept at 4 to 9, to produce an aqueous polymer dispersion,

ii) spray drying the aqueous dispersion to produce a solid composition in powdery form, wherein the dispersion particles are maintained at a temperature of not more than 100°C.

11. Method according to claim 10, characterized in that the amount of the epoxide group-containing ethylenically unsaturated monomer is 1 to 25 % by weight.

12. Method according to claim 10 or 11, characterized in that the polymerization is carried out between 50 and 100°C.

13. Method according to claim 10, 11 or 12, characterized in that the polymerization is carried out in presence of an emulsifier.

14. Method according to claim 13, characterized in that the emulsifier is an anionic, a cationic and/or a non-ionic emulsifier.

15. Method according to at least one of claims 10 to 14, characterized in that an additional polymeric protective colloid is added to the aqueous dispersion prior to spray drying.

16. Method according to claim 15, characterized in that the additional polymeric protective colloid added is polyvinyl alcohol and/or polyvinyl pyrrolidone.

17. Method according to at least one of claims 10 to 16, characterized in that the addition of the epoxide group-containing ethylenically unsaturated comonomer takes place whereby a core/shell-structure appears in the copolymer, the proportion of the monomer present in the shell being bigger than in the core.

18. Use of the chemical composition according to at least one of claims 1 to 9 in cement bonded systems containing plastic, preferably in mortar, cement paints and adhesives, and plastic-bonded cement-free binders, preferably in gypsum mortar, casts, carpet-, wood- and floor-adhesives as well as in wallpaper glues, dispersion paints and glass-fiber-reinforced composite systems.

Patentansprüche

1. Chemische Zusammensetzung, die in wäßrigem Milieu pergerbar ist, enthaltend a) sowohl ein Copolymer auf der Basis von Styrol und/oder mindestens einem Alkyl(meth)acrylat, dessen Alkylgruppe eine Kettenlänge von 1 bis 14 Kohlenstoffatomen aufweist, wobei die Menge an Styrol und/oder Alkyl(meth)acrylat, bezogen auf das Gesamtgewicht an Monomeren, ≥ 50 Gewichts-% ist, als auch mindestens ein weiteres Comonomer und b) ein wasserlösliches polymeres Schutzkolloid, wobei 2 bis 30 Gewichtsteile des wasserlöslichen polymeren Schutzkolloids zu 100 Gewichtsteilen des Copolymers gegeben werden, sowie c) wahlweise weitere Additive, dadurch gekennzeichnet, daß das Copolymer 0,1 bis 50 Gewichts-% an Epoxidgruppen enthaltenden ethylenisch ungesättigten Comonomereinheiten umfaßt und diese Einheiten reaktive Epoxidgruppen enthalten, wobei polymere Acrylschutzkolloide, die Monomereinheiten mit mindestens einer Aldehyd- oder Ketongruppe aufweisen, davon ausgenommen sind.

2. Chemische Zusammensetzung nach Anspruch 1, dadurch gekennzeichnet, daß die chemische Zusammensetzung

zung ein wasserlösliches Schutzkolloid in Form von Polyvinylalkohol, Polyvinylpyrrolidon und/oder Polyacrylat enthält.

3. Chemische Zusammensetzung nach Anspruch 2, dadurch gekennzeichnet, daß der Polyvinylalkohol ein mittleres Molekulargewicht von 10.000 bis 200.000 und einen Hydrolysegrad von 80 bis 95 % aufweist, und das Polyvinylpyrrolidon ein mittleres Molekulargewicht von 1.000 bis 1.000.000 besitzt.
4. Chemische Zusammensetzung nach mindestens einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß das Alkyl(meth)acrylat Butyl(meth)acrylat, 2-Ethylhexyl(meth)acrylat und/oder Ethyl(meth)acrylat ist.
5. Chemische Zusammensetzung nach mindestens einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß das Epoxidgruppen enthaltende ethylenisch ungesättigte Comonomer ein Ester oder ein Ether ist.
6. Chemische Zusammensetzung nach Anspruch 5, dadurch gekennzeichnet, daß der Ester Glycidyl(meth)acrylat und der Ether Glycidylvinylether und/oder Glycidylallylether ist.
7. Chemische Zusammensetzung nach mindestens einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Menge an Styrol und/oder Alkyl(meth)acrylat 70 bis 80 Gewichts-% beträgt.
8. Chemische Zusammensetzung nach mindestens einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das Copolymer 1 bis 25 Gewichts-% an die Epoxidgruppen enthaltenden ethylenisch ungesättigten Comonomereinheiten enthält.
9. Chemische Zusammensetzung nach mindestens einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Epoxidfunktionalität des in das Copolymer einpolymerisierten, Epoxidgruppen enthaltenden ethylenisch ungesättigten Comonomers mindestens 30 % beträgt.
10. Verfahren zur Herstellung von Dispersionen mit einer chemischen Zusammensetzung nach mindestens einem der Ansprüche 1 bis 9, wobei das Verfahren umfaßt:
 - i) die Polymerisation von Monomeren, umfassend ≥ 50 Gewichts-%, bezogen auf das Gesamtgewicht an Monomeren, an Styrol und/oder Alkyl(meth)acrylat, 0,1 bis 50 Gewichts-%; bezogen auf das Gesamtgewicht an Monomeren, eines Epoxidgruppen enthaltenden ethylenisch ungesättigten Comonomers sowie wahlweise weitere Additive, in einer wäßrigen Phase als Dispersionsmedium in Anwesenheit vom wasserlöslichen polymeren Schutzkolloid und eines Radikaleninitiators, wobei der pH-Wert auf 4 bis 9 gehalten wird, um eine wäßrige Polymerdispersion herzustellen, und
 - ii) die Sprühtrocknung der wäßrigen Dispersion, um eine feste Zusammensetzung in Form von Pulver herzustellen, wobei die Dispersionsteilchen auf einer Temperatur von nicht mehr als 100 °C gehalten werden.
11. Verfahren nach Anspruch 10, dadurch gekennzeichnet, daß die Menge an Epoxidgruppen enthaltendem ethylenisch ungesättigtem Monomer 1 bis 25 Gewichts-% beträgt.
12. Verfahren nach Anspruch 10 oder 11, dadurch gekennzeichnet, daß die Polymerisation zwischen 50 und 100 °C durchgeführt wird.
13. Verfahren nach Anspruch 10, 11 oder 12, dadurch gekennzeichnet, daß die Polymerisation in Anwesenheit eines Emulgators durchgeführt wird.
14. Verfahren nach Anspruch 13, dadurch gekennzeichnet, daß der Emulgator ein anionischer, ein kationischer und/oder ein nichtionogener Emulgator ist.
15. Verfahren nach mindestens einem der Ansprüche 10 bis 14, dadurch gekennzeichnet, daß ein zusätzliches polymeres Schutzkolloid der wäßrigen Dispersion vor der Sprühtrocknung zugegeben wird.
16. Verfahren nach Anspruch 15, dadurch gekennzeichnet, daß das zugegebene zusätzliche polymere Schutzkolloid Polyvinylalkohol und/oder Polyvinylpyrrolidon ist.
17. Verfahren nach mindestens einem der Ansprüche 10 bis 16, dadurch gekennzeichnet, daß eine Zugabe des Ep-

oxidgruppen enthaltenden ethylenisch ungesättigten Comonomers stattfindet, wobei im Copolymer eine Kern-Mantel-Struktur auftritt, wobei der Anteil an im Mantel vorhandenem Monomer größer ist als der im Kern.

18. Verwendung der chemischen Zusammensetzung nach mindestens einem der Ansprüche 1 bis 9 in zementgebundenen, Kunstharz enthaltenden Systemen, vorzugsweise in Mörtel, Zementfarben und -klebstoffen, sowie in kunstharzgebundenen zementfreien Bindemitteln, vorzugsweise in Gipsmörtel, Putzarten, Teppich-, Holz- und Fußbodenklebstoffen sowie in Tapetenleimen, Dispersionsfarben und glasfaserverstärkten Verbundsystemen.

Revendications

1. Composition chimique, qui est redispersable dans des milieux aqueux, contenant a) un copolymère à base de styrène et/ou d'au moins un (méth)acrylate d'alkyle dont le groupe alkyle a une longueur de chaîne de 1 à 14 atomes de carbone, la quantité de styrène et/ou de (méth)acrylate d'alkyle étant $\geq 50\%$ en poids, sur la base des monomères totaux, ainsi qu'au moins un comonomère supplémentaire, et b) un colloïde protecteur polymérique hydrosoluble, dans laquelle une quantité de 2 à 30 parties en poids du colloïde protecteur polymérique hydrosoluble est fournie pour 100 parties en poids du copolymère, ainsi que c) des additifs supplémentaires facultatifs, caractérisée en ce que le copolymère comprend 0,1 à 50% en poids de motifs d'un comonomère à insaturation éthylénique contenant des groupes époxyde et lesdits motifs contiennent des groupes époxyde réactifs, les colloïdes protecteurs acryliques polymériques ayant des motifs monomériques avec au moins un groupe aldéhyde ou cétone étant exclus.
2. Composition chimique suivant la revendication 1, caractérisée en ce qu'elle contient un colloïde protecteur hydrosoluble sous forme d'un polymère d'alcool vinylique, de polyvinylpyrrolidone et/ou d'un polyacrylate.
3. Composition chimique suivant la revendication 2, caractérisée en ce que le polymère d'alcool vinylique a un poids moléculaire moyen compris dans l'intervalle de 10 000 à 200 000 et un degré d'hydrolyse de 80 à 95%, et la polyvinylpyrrolidone a un poids moléculaire moyen compris dans l'intervalle de 1000 à 1 000 000.
4. Composition chimique suivant au moins l'une des revendications 1 à 3, caractérisée en ce que le (méth)acrylate d'alkyle est le (méth)acrylate de butyle, le (méth)acrylate de 2-éthylhexyle et/ou le (méth)acrylate d'éthyle.
5. Composition chimique suivant au moins l'une des revendications 1 à 4, caractérisée en ce que le comonomère à insaturation éthylénique contenant des groupes époxyde est un ester ou un éther.
6. Composition chimique suivant la revendication 5, caractérisée en ce que l'ester consiste en (méth)acrylate de glycidyle et l'éther consiste en éther de glycidyle et vinyle et/ou éther de glycidyle et d'allyle.
7. Composition chimique suivant au moins l'une des revendications précédentes, caractérisée en ce que la quantité de styrène et/ou de (méth)acrylate d'alkyle est comprise dans l'intervalle de 70 à 80% en poids.
8. Composition chimique suivant au moins l'une des revendications précédentes, caractérisée en ce que le copolymère contient 1 à 25% en poids de motifs du comonomère à insaturation éthylénique contenant des groupes époxyde.
9. Composition chimique suivant au moins l'une des revendications précédentes, caractérisée en ce que la fonctionnalité époxyde du comonomère à insaturation éthylénique contenant des groupes époxyde polymérisé dans le copolymère est présente en une quantité d'au moins 30%.
10. Procédé pour la production de dispersions ayant une composition chimique suivant au moins l'une des revendications 1 à 9, procédé qui comprend les étapes consistant
 - i) à polymériser des monomères constitués d'une quantité $\geq 50\%$ en poids, sur la base des monomères totaux, de styrène et/ou de (méth)acrylate d'alkyle, 0,1 à 50% en poids, sur la base des monomères totaux, d'un comonomère à insaturation éthylénique contenant des groupes époxyde, et, facultativement, d'additifs supplémentaires, dans une phase aqueuse servant de milieu de dispersion en présence d'un colloïde protecteur polymérique hydrosoluble et d'un initiateur radicalaire, la valeur de pH étant maintenue dans la plage de 4 à 9, pour produire une dispersion aqueuse de polymère,

ii) à sécher par pulvérisation la dispersion aqueuse pour produire une composition solide sous forme pulvérulente, les particules de la dispersion étant maintenues à une température non supérieure à 100°C.

- 5 11. Procédé suivant la revendication 10, caractérisé en ce que la quantité du monomère à insaturation éthylénique contenant des groupes époxyde est comprise dans l'intervalle de 1 à 25% en poids.
12. Procédé suivant la revendication 10 ou 11, caractérisé en ce que la polymérisation est effectuée à une température comprise dans l'intervalle de 50 à 100°C.
- 10 13. Procédé suivant la revendication 10, 11 ou 12, caractérisé en ce que la polymérisation est effectuée en présence d'un émulsionnant.
14. Procédé suivant la revendication 13, caractérisé en ce que l'émulsionnant est un émulsionnant anionique, un émulsionnant cationique et/ou un émulsionnant non ionique.
- 15 15. Procédé suivant au moins l'une des revendications 10 à 14, caractérisé en ce qu'un colloïde protecteur polymérique supplémentaire est ajouté à la dispersion aqueuse avant le séchage par pulvérisation.
- 20 16. Procédé suivant la revendication 15, caractérisé en ce que le colloïde protecteur polymérique supplémentaire ajouté consiste en un polymère d'alcool vinylique et/ou polyvinylpyrrolidone.
- 25 17. Procédé suivant au moins l'une des revendications 10 à 16, caractérisé en ce que l'addition du comonomère à insaturation éthylénique contenant des groupes époxyde s'effectue en provoquant l'apparition d'une structure de noyau/enveloppe dans le copolymère, la proportion du monomère présent dans l'enveloppe étant supérieure à celle existant dans le noyau.
- 30 18. Utilisation de la composition chimique suivant au moins l'une des revendications 1 à 9 dans des formulations liées au ciment, contenant une matière plastique, de préférence dans un mortier, des peintures et adhésifs pour ciment, et dans des liants sans ciment liés avec une matière plastique, de préférence dans un mortier au gypse, des enduits, des adhésifs pour tapis, pour le bois et pour les sols et également dans les colles pour le papier peint, les peintures en dispersion et des formulations composites renforcées avec des fibres de verre.